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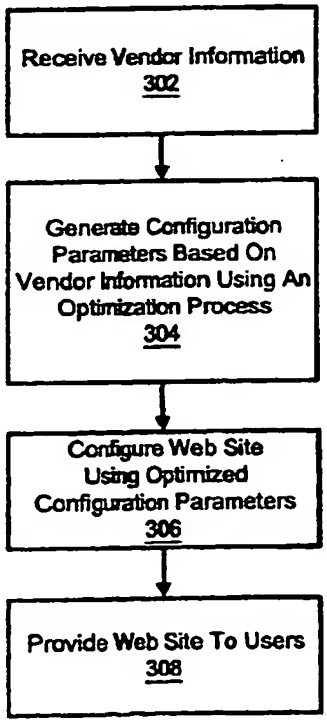
(54) Title: SYSTEM AND METHOD FOR CONFIGURING AN ELECTRONIC COMMERCE SITE USING AN OPTIMIZATION PROCESS



(57) Abstract: A system and method for configuring an e-commerce site maintained by an e-commerce vendor. In this embodiment, the method includes receiving or collecting vendor information, wherein the vendor information is related to products offered by the e-commerce vendor. The method may then generate a configuration of the e-commerce site in response to the vendor information, wherein generation of the e-commerce site configuration uses an optimization process. The generation of the configuration of the e-commerce site may comprise inputting the information into an optimizer, and the optimizer generating the configuration in response to the information. In an alternate embodiment, the system and method are operable to provide one or more inducements to a user conducting an e-commerce transaction, wherein the inducements are intended to encourage or entice the user to complete the transaction in a desired way, such as purchasing a product, purchasing additional products, etc. The inducements are generated by an optimization process to optimize a desired commercial result of the vendor. The method may include receiving, collecting or storing information which is related to the e-commerce transaction. The information may then be used to update a predictive model used in the optimization process, or in generating the one or more inducements. The method then may include generating one or more inducements in response to the information, wherein the generation uses an optimization process. The generation of the one or more inducements may comprise inputting the information into an optimizer, and the optimizer generating one or more inducements in response to the information.

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TITLE: SYSTEM AND METHOD FOR CONFIGURING AN ELECTRONIC COMMERCE SITE USING AN OPTIMIZATION PROCESS

Background of the Invention

Field of the Invention

The present invention generally relates to the fields of Internet e-commerce and ancillary systems. More particularly, the present invention relates to a system and method for generating and providing optimized inducements during various stages of e-commerce transactions, as well as providing optimized e-commerce site configurations.

Description of the Related Art

Electronic commerce has become an increasingly popular form of commerce in the United States and throughout the world. In general, electronic commerce, often referred to as e-commerce or Internet-based commerce, provides vendors and service providers the ability to greatly increase their sales channel and distribution network with minimal cost. An electronic commerce site provides a convenient and effective mechanism for potential customers to use, select and purchase goods or services in an easy and simple fashion.

When a user desires to purchase a product from an e-commerce site, the user first connects to the site, such as on the Internet. When the user connects to the e-commerce site, the e-commerce site may display a graphical user interface (GUI) on the client browser of the client system that the user may use to evaluate, select, and/or purchase the product. The e-commerce server may, for example, support a "shopping cart" metaphor for allowing a user of the client computer to select various products for purchase, wherein selected products may be placed into the "shopping cart" for purchase.

When the user of the client computer has selected one or more products for purchase from the e-commerce server and desires to "check out," then the e-commerce server may display a page on the client browser which displays various pricing information and payment options for the user to select. The user may then complete the purchase of one or more of the products in the shopping cart, or abandon the shopping cart without purchasing anything.

One problem with many e-commerce transactions is that in many instances the shopping cart is partially or completely abandoned during check out. This reduces the amount of revenues to the e-commerce vendor.

The look and feel of an e-commerce site may have an effect upon the purchasing behavior of a user. Typically, e-commerce sites are configured manually, and the commercial results depend on the subjective judgment of web site designers, which may prove to be unreliable from a commercial perspective.

Vendor revenue may be substantially increased if the fraction of transactions that are abandoned is decreased by even modest amounts, or if the average number of products purchased per user session is increased. Prior marketing techniques have used a 'one size fits all' approach to advertising and marketing incentives, which offer little in the way of improving current sales and marketing response rates. Prior marketing techniques have also used more rudimentary forms of predictive modeling. These prior systems typically have involved "scoring" various methods or tactics and then selecting the method with the highest score.

However, current e-commerce marketing techniques do not take advantage of modern neural-net based predictive modeling. Prior e-commerce marketing techniques have also failed to utilize modern constrained optimization techniques to attain desired commercial results.

Therefore, an improved system and method are desired for providing optimized inducements and incentives during an e-commerce transaction. An improved system and method are also desired for providing improved e-commerce site configurations.

Summary of the Invention

The present invention comprises various embodiments of an improved system and method for conducting e-commerce.

In one embodiment, the system and method operate to configure an electronic commerce site maintained by an e-commerce vendor. The configured e-commerce site is intended to satisfy some objective, such as reduce inventory, increase profits, or otherwise encourage or entice users or customers to complete transactions on the site. The e-commerce site configuration is generated by an optimization process to optimize a desired commercial result of the vendor.

The present invention is preferably implemented in an e-commerce system. The system may include an electronic commerce (e-commerce) server, which is maintained by an e-commerce vendor. The e-commerce server is coupled through a network, such as the Internet, to various client systems operated by users. The e-commerce server, or a separate server, may include optimization software which operates to generate a configuration of the e-commerce site, wherein the optimization software uses constrained optimization techniques. Various users of the client systems may then conduct e-commerce transactions with the e-commerce server.

In one embodiment, the method operates as follows. The method may include receiving or collecting vendor information, wherein the vendor information is related to products offered by the e-commerce vendor. The vendor information may include an inventory of products offered by the e-commerce vendor, time and date information and/or competitive information of competitors to the e-commerce vendor. Thus the vendor information is preferably not specific to any one user, but rather is related generally to the e-commerce vendor's products or web site or other non user-specific information. The method may also (or instead) include receiving or collecting customer information, wherein the customer information is related to a plurality or all of the customers or potential customers of the e-commerce vendor. The information may then be used to update a predictive model used in the optimization process, or otherwise used in generating the e-commerce site configuration.

The method then may include generating an e-comerce site configuration in response to the information, wherein the generation uses an optimization process. In the preferred embodiment, the generation of the e-comerce site configuration may comprise inputting the information into an optimizer, and the optimizer generating the e-comerce site configuration in response to the information.

The generation of the e-comerce site configuration preferably comprises providing various data to the optimizer to enable the optimizer to generate the e-comerce site configuration. In one embodiment, the method comprises inputting the vendor and/or customer information referenced above into at least one predictive model to generate one or more action variables. The action variables may comprise predictive user or vendor behaviors

corresponding to the information. The predictive model may comprise a trained neural network or other type of predictive model.

In one embodiment, designed experiments may be used to create the initial training data for a neural network model. When the system or method is initially installed on an e-commerce server, the method may present a range of e-comerce site configurations to a subset of users or customers. Their resultant behaviors to these configurations may be recorded, and then combined with vendor data or other data. This information may then be used as the initial training data for the neural network model. This process may be repeated at various times to update the model, as desired.

The optimizer may then receive one or more constraints, wherein the constraints comprise limitations on one or more resources, e.g., the constraints may comprise limitations on the configurations of the site. The optimizer may further receive an objective function, wherein the objective function comprises a function of the action variables. The objective function represents the desired commercial goal of the e-commerce vendor, e.g., to increase profits, increase market share, reduce inventory, etc. The constraint and objective functions may be functions of the above-mentioned action variables. The optimizer may then solve the objective function subject to the constraints. The optimizer may then generate the e-comerce site configuration based on the solved objective function. Thus the optimizer preferably uses constrained optimization techniques.

After the optimizer generates, (e.g., selects or creates) the e-comerce site configuration in response to the received data, the e-commerce server, or a separate server, then is configured with this site configuration. The e-comerce site configuration is provided or made available to customers, where the web site is displayed, preferably by a browser, to the user of the client system. As discussed above, the web site configuration is preferably designed to achieve a desired commercial result.

Therefore, the method may include generating a configuration of the e-commerce site in response to the vendor information and/or the customer information, wherein generation of the e-commerce site configuration uses an optimization process. In one embodiment, generating the configuration of the e-commerce site includes modifying one or more configuration parameters of the e-commerce site and/or generating one or more new configuration parameters of the e-commerce site. For example, modification of one or more configuration parameters of the e-commerce site may include modifying one or more of a color or a layout of the e-commerce site. Modification of one or more configuration parameters of the e-commerce site may also include modifying content comprised in or presented by the e-commerce site, such as text, images, graphics, audio, or other types of content. Modification of one or more configuration parameters of the e-commerce site may also include incorporating one or more inducements, such as promotions, advertisements, or product purchase discounts or incentives, in the e-commerce site in response to the vendor information.

In another embodiment, the system and method operate to provide one or more inducements to a user conducting an e-commerce transaction, wherein the inducements are intended to encourage or entice the user to complete the transaction in a desired way, such as purchasing a product, purchasing additional products, etc. The inducements are generated by an optimization process to optimize a desired commercial result of the vendor.

The present invention is preferably implemented in an e-commerce system. The system may include an electronic commerce (e-commerce) server, which is maintained by an e-commerce vendor. The e-commerce server is coupled through a network, such as the Internet, to various client systems operated by users. The e-commerce

server. or a separate server. may include optimization software which operates to generate inducements to be provided to the users. wherein the optimization software uses constrained optimization techniques. Various users of the client systems may conduct e-commerce transactions with the e-commerce server. An e-commerce transaction may include a portion. subset or all of any of the various stages of a user purchase of a product from an e-commerce site. including selection of the e-commerce site. browsing of products on the e-commerce site. selection of one or more products from the e-commerce site. such as using a "shopping cart" metaphor, purchasing the one or more products or "checking out." and delivery of the product. During any stage of the e-commerce transaction. the system and method of the present invention may operate to generate and display one or more inducements to the user.

In one embodiment. the method operates as follows. The method may include receiving. collecting or storing information which is related to the e-commerce transaction. The various types of information "related to the e-commerce transaction" may include user demographic information. user site navigation information. time and date information. inventory information of products offered by the e-commerce vendor. and/or competitive information of competitors to the e-commerce vendor. or other information which is useable in generating inducements to display to users during an e-commerce transaction. The information may then be used to update a predictive model used in the optimization process. or in generating the one or more inducements. The method may also operate to determine when to generate an inducement. e.g., at which point or step in a user's "click-stream" to make provide an inducement.

The method then may include generating one or more inducements in response to the information. wherein the generation uses an optimization process. In the preferred embodiment, the generation of the one or more inducements may comprise inputting the information into an optimizer. and the optimizer generating one or more inducements in response to the information.

The generation of the one or more inducements preferably comprises providing various data to the optimizer to enable the optimizer to generate the inducements. In one embodiment. the method comprises inputting the information referenced above which is related to the e-commerce transaction into at least one predictive model to generate one or more action variables. The action variables may comprise predictive user behaviors corresponding to the information. The predictive model may comprise a trained neural network or other type of predictive model.

In one embodiment. designed experiments may be used to create the initial training data for a neural network model. When the system or method is initially installed on an e-commerce server, the method may present a range of inducements to a subset of users or customers. Their resultant behaviors to these inducement may be recorded. and then combined with demographic and other data. This information may then be used as the initial training data for the neural network model. This process may be repeated at various times to update the model. as desired.

The optimizer may then receive one or more constraints. wherein the constraints comprise limitations on one or more resources. e.g.. the constraints may comprise limitations on the dollar amount of an inducement. The optimizer may further receive an objective function. wherein the objective function comprises a function of the action variables. The objective function represents the desired commercial goal of the e-commerce vendor. e.g.. to increase profits. increase market share. etc. The constraint and objective functions may be functions of the above-

mentioned action variables. The optimizer may then solve the objective function subject to the constraints. The optimizer may then generate one or more inducements based on the solved objective function. Thus the optimizer preferably uses constrained optimization techniques.

After the optimizer generates, (e.g., selects or creates) one or more inducements in response to the received data, the e-commerce server, or a separate server, then provides the one or more generated inducements to the user. The inducement(s) are provided to the client system of a user, where the inducements are displayed, preferably by a browser, to the user of the client system. As discussed above, the inducement(s) are preferably designed to achieve a desired commercial result, e.g., to encourage or entice the user to complete the transaction in a desired way, such as by purchasing a product, purchasing additional products, selecting a particular e-commerce site, providing desired user demographic information, etc.

Brief Description of the Drawings

A better understanding of the present invention can be obtained when the following detailed description of the preferred embodiment is considered in conjunction with the following drawings, in which:

Figure 1 illustrates an e-commerce system that operates according to one embodiment of the present invention;

Figure 1a illustrates an e-commerce system according to an alternate embodiment of the present invention;

Figure 1b illustrates an e-commerce system according to an alternate embodiment of the present invention;

Figure 2 is a flowchart diagram illustrating operation of an e-commerce transaction according to an embodiment of the present invention;

Figure 3 is a flowchart illustrating operation of generating a configuration of an e-commerce site according to an embodiment of the present invention;

Figure 4a is a block diagram illustrating an overview of optimization according to one embodiment;

Figure 4b is a dataflow diagram illustrating an overview of optimization according to one embodiment;

Figure 5 illustrates a single model according to one embodiment;

Figure 6 illustrates multiple models for multiple products and a single customer according to one embodiment;

Figure 7 illustrates multiple models for multiple customers and a single product according to one embodiment;

Figure 8 illustrates a closed-loop software architecture for e-commerce according to one embodiment;

Figure 9 is a flowchart for a web touch-point application according to one embodiment.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

Detailed Description of the Embodiments

Figure 1: Network System for Performing E-Commerce

Figures 1, 1a, and 1b illustrate a simplified and exemplary electronic commerce (e-commerce) or Internet commerce network system according to various embodiments of the present invention. The system shown in Figures 1, 1a, and 1b may utilize an optimization process to provide targeted inducements, e.g., promotions or advertising, to a user, such as during an e-commerce transaction. The system shown in Figures 1, 1a and 1b may also utilize an optimization process to configure the e-commerce site (also called a web site) of an e-commerce vendor.

As shown in Figure 1, the system may include an e-commerce server 102. The e-commerce server 102 is preferably maintained by a vendor who offers products, such as goods or services, for sale over a network, such as the Internet. One example of an e-commerce vendor is Amazon.com, which sells books and other items over the Internet.

As used herein, the term "product" is intended to include various types of goods or services, such as books, music, furniture, online auction items, clothing, consumer electronics, software, medical supplies, computer systems etc., or various services such as loans (e.g., auto, mortgage, and home re-financing loans), securities (e.g., CDs, stocks, retirement accounts, cash management accounts, bonds, and mutual funds), ISP service, content subscription services, travel services, or insurance (e.g., life, health, auto, and home owner's insurance), among others.

As shown, the e-commerce server 102 may be connected to a network 104, preferably the Internet. The Internet is currently the primary mechanism for performing e-commerce. However, the network 104 may be any of various types of wide-area networks and/or local area networks, or networks of networks, such as the Internet, which connects computers and/or networks of computers together, thereby providing the connectivity for enabling e-commerce to operate. Thus, the network 104 may be any of various types of networks, including wired networks, wireless networks, etc. In the preferred embodiment, the network 104 is the Internet using standard protocols such as TCP/IP, http, and html or xml.

A client computer 106 may also be connected to the Internet. The client system 106 may be a computer system, network appliance, Internet appliance, personal digital assistant (PDA) or other system. The client computer system 106 may execute web browser software for allowing a user of the client computer 106 to browse and/or search the network 104, e.g., the Internet, as well as enabling the user to conduct transactions or commerce over the network 104. The network 104 is also referred to herein as the Internet 104. When the user of the client computer 106 desires to browse or purchase a product from a vendor over the Internet 104, the web browser software preferably accesses the e-commerce site of the respective e-commerce server, such as e-commerce server 102. The client 106 may access a web page of the e-commerce server 102 directly or may access the site through a link from a third party. The user of the client computer 106 may also be referred to as a customer.

When the client web browser accesses the web page of the e-commerce server 102, the e-commerce server 102 provides various data and information to the client browser on the client system 106, possibly including a graphical user interface (GUI) that displays the products offered, descriptions and prices of these products, and other information that would typically be useful to the purchaser of a product.

The e-commerce server 102, or another server, may also provide one or more inducements to the client computer system 106, wherein the inducements may be generated using an optimization process or an experiment engine according to the present invention. In one embodiment of the invention, the e-commerce server 102 includes an optimizer, such as an optimization software program, which is executable to generate the one or more inducements in response to various information related to the e-commerce transaction. The operation of the optimizer in generating the inducements to be provided is discussed further below.

As used herein, the term "inducement" is intended to include one or more of advertising, promotions, discounts, offers or other types of incentives which may be provided to the user. In general, the purpose of the inducement is to achieve a desired commercial result with respect to a user. For example, one purpose of the inducement may be to encourage or entice the user to complete the purchase of the product, or to encourage or entice the user to purchase additional products, either from the current e-commerce vendor or another vendor. For example, an inducement may be a discount on purchase of a product from the e-commerce vendor, or a discount on purchase of a product from another vendor. An inducement may also be an offer of a free product with purchase of another product. The inducement may also be a reduction or discount in shipping charges associated with the product, or a credit for future purchases, or any other type of incentive. Another purpose of the inducement may be to encourage or entice the user to select or subscribe to a certain e-commerce site, or to encourage the user to provide desired information, such as user demographic information.

The inducement(s) may be provided to the user during any part of an e-commerce transaction. As used herein, an e-commerce transaction may include a portion, subset or all of any stage of a user purchase of a product from an e-commerce site, including selection of the e-commerce site, browsing of products on the e-commerce site, selection of one or more products from the e-commerce site, such as using a "shopping cart" metaphor, purchasing the one or more products or "checking out," and delivery of the product. During any stage of the e-commerce transaction, the system and method of the present invention may operate to generate and display one or more inducements to the user. In one embodiment, the optimization process may determine times, such as during a user's click flow in navigating the e-commerce site, for provision of the inducements to the user. Thus the optimization process may optimize the types of inducements provided as well as the timing of delivery of the inducements.

As shown in Figure 1a, an information database 108 may be coupled to or comprised in the e-commerce server 102. Alternatively, or in addition, a separate database server 110 may be coupled to the network 104, wherein the separate database server 110 includes an information database 108. The information database 108 and/or database server 110 may store information related to the e-commerce transaction, as described above. The e-commerce server 102 may access this information from the database 108 and/or database server 110 for use by the optimization program in generating the one or more inducements to display to a user. Thus, the e-commerce server 102 may collect and/or store its own information database 108, and/or may access this information from the separate database server 110.

As noted above, the information database 108 and/or database server 110 may store information related to the e-commerce transaction. The information "related to the e-commerce transaction" may include user demographic information, i.e., demographic information of users, such as age, sex, marital status, occupation, financial status, income level, purchasing habits, hobbies, past transactions of the user, past purchases of the user,

commercial activities of the user, affiliations, memberships, associations, historical profiles, etc. The information "related to the e-commerce transaction" may also include "user site navigation information", which comprises information on the user's current or prior navigation of an e-commerce site of the e-commerce vendor. For example, where the e-commerce vendor maintains an e-commerce site, and the site receives input from a user during any stage of an e-commerce transaction, the user site navigation information may comprise information on the user's current navigation of the e-commerce site of the e-commerce vendor. The information "related to the e-commerce transaction" may also include time and date information, inventory information of products offered by the e-commerce vendor, and/or competitive information of competitors to the e-commerce vendor. The information "related to the e-commerce transaction" may further include number and dollar amount of products being purchased (or comprised in the shopping cart), "costs" associated with various inducements, the cost of the transaction being conducted, as well as the results from previous transactions. The information "related to the e-commerce transaction" may also include various other types of information related to the e-commerce transaction or information which is useable in selecting or generating inducements to display to users during an e-commerce transaction.

As noted above, the e-commerce server 102 may include an optimization process, such as an optimization software program, which is executable to use the information "related to the e-commerce transaction" from the information database 108 or the database server 110 to generate the one or more inducements to be provided to the user.

As shown in Figure 1b, the system may also include a separate optimization server 112 and/or a separate inducement server 122. As noted above, the e-commerce server 102 may instead implement the functions of both the optimization server 112 and the inducement server 122.

The optimization server 112 may couple to the information database 108 and/or may couple through the Internet to the database server 110. Alternatively, the information database 108 may be comprised in the optimization server 112. The optimization server 112 may also couple to the e-commerce server 102.

The optimization server 112 may include the optimization software program and may execute the optimization software program using the information to generate the one or more inducements to be provided to the user. Thus, the optimization software program may be executed by the e-commerce server 102 or by the separate optimization server 112. The optimization server 112 may also store the inducements which are provided to the client computer system 106, or the inducements may be provided by the e-commerce server 102. The optimization server 112 may be operated directly by the e-commerce vendor who operates the e-commerce server 102, or by a third party company. Thus, the optimization server 112 may offload or supplement the operation of the e-commerce server 102, i.e., offload this task from the e-commerce vendor.

The system may also include a separate inducement server 122 which may couple to the Internet 104 as well as to one or both of the optimization server 112 and the e-commerce server 102. The inducement server 122 may operate to receive information regarding inducements generated by the optimization software program, either from the e-commerce server 102 or the optimization server 112, and source the inducements to the client 106. Alternatively, the inducement server 122 may also include the optimization software program for generating the inducements to be provided to the client computer system 106. The inducement server 122 may be operated directly by the e-commerce vendor who operates the e-commerce server 102, by the third party company who

operates the optimization server 112, or by a separate third party company. Thus, the inducement server 122 may offload or supplement the operation of the e-commerce server 102 and/or the optimization server 112, i.e., offload this task from the e-commerce vendor or the optimization provider who operates the optimization server 112.

In the embodiments of Figures 1, 1a, and 1b, one or both of the optimization server 112 or the inducement server 122 may not be coupled to the Internet for security reasons, and thus the optimization server 112 and/or inducement server 122 may use other means for communicating with the e-commerce server 102. For example, the optimization server 112 and/or inducement server 122 may connect directly to the e-commerce server 102, or directly to each other, (not through the Internet), e.g., through a direct connection such as a dedicated T1 line, frame relay, Ethernet LAN, DSL, or other dedicated (and presumably more secure) communication channel.

It is noted that the embodiments of Figures 1, 1a and 1b are exemplary only, and the system and method of the present invention may be implemented in various different embodiments, as desired. Thus the system and method of the present invention may be implemented using one or more computer systems, e.g., a single server or a number of distributed servers, connected in various ways, as desired.

Also, Figures 1, 1a and 1b illustrate an exemplary embodiment including one e-commerce server 102, one client computer system 106, one optimization server 112, and one inducement server 122 which may be connected to the Internet 104. However, it is noted that the present invention may be utilized with respect to any number of e-commerce servers 102, clients 106, optimization servers 112, and/or inducement servers 122.

Further, in addition to the various servers described above, the e-commerce system may include various other components or functions, such as credit card verification, payment, inventory and shipping, among others.

Servers 102, 112, and 122

Each of the e-commerce server 102, optimization server 112, and/or the inducement server 122 may include various standard components such as one or more processors or central processing units and one or more memory media, and other standard components, e.g., a display device, input devices, a power supply, etc. Each of the e-commerce server 102, optimization server 112, and/or the inducement server 122 may also be implemented as two or more different computer systems.

At least one of the e-commerce server 102, optimization server 112, and/or the inducement server 122 preferably includes a memory medium on which computer programs according to the present invention are stored. The term "memory medium" is intended to include various types of memory or storage, including an installation medium, e.g., a CD-ROM, or floppy disks 160, a computer system memory, e.g., RAM, such as DRAM, SRAM, EDO RAM, Rambus RAM, etc., or a non-volatile memory such as a magnetic media, e.g., a hard drive, or optical storage. The memory medium may comprise other types of memory as well, or combinations thereof. In addition, the memory medium may be located in a first computer in which the programs are executed, or may be located in a second different computer which connects to the first computer over a network. In the latter instance, the second computer provides the program instructions to the first computer for execution. Also, the servers 102, 112 and/or 122 may take various forms, including a computer system, mainframe computer system, workstation, or other device. In general, the term "computer system" or "server" can be broadly defined to encompass any device having a processor that executes instructions from a memory medium.

The memory medium preferably stores an optimization software program for implementing the optimized inducement generation process of the present invention. The software program may be implemented in any of various ways, including procedure-based techniques, component-based techniques, and/or object-oriented techniques, among others. For example, the software program may be implemented using ActiveX controls, C++ objects, Java objects, Microsoft Foundation Classes (MFC), or other technologies or methodologies, as desired. A CPU of one of the servers 102, 112 or 122 executing code and data from the memory medium comprises a means for implementing an optimized inducement generation process according to the methods or flowcharts described below.

Various embodiments further include receiving or storing instructions and/or data implemented in accordance with the foregoing description upon a carrier medium. Suitable carrier media include memory media or storage media such as magnetic or optical media, e.g., disk or CD-ROM, as well as signals such as electrical, electromagnetic, or digital signals, conveyed via a communication medium such as networks and/or a wireless link.

The optimization server 112, the e-commerce server 102, and/or the inducement server 122 may be programmed according to one embodiment of the invention to generate and/or provide one or more inducements to a user conducting an e-commerce transaction. In the following description, for convenience, the system and method of the present invention is described assuming the e-commerce server 102 implements or executes the optimization process, i.e., executes the optimization software program (or implements the function of the optimization server 112). This is not intended to limit the various possible embodiments of the present invention, it being noted here and above that the present invention may be implemented in the e-commerce server 102, a separate optimization server 112 or inducement server 122, or various other embodiments or configurations.

The present invention provides a number of benefits to e-commerce vendors. First, the system and method may increase the amount of sales and revenue for e-commerce vendors through increased closure of purchases. The present invention also provides a number of benefits to the user, including various inducements or incentives to the user that add value to the user's purchases.

Figures 2 and 3 - Flowchart Diagrams

Figures 2 and 3 are flowchart diagrams that illustrate high-level operation of embodiments of the present invention. It is noted that various of the steps in the flowcharts below may occur concurrently and/or in different orders, or may be absent in some embodiments.

Figure 2 - Providing Optimized Inducements to a User Conducting an E-Commerce Transaction

Figure 2 is a flowchart diagram that illustrates one embodiment of the present invention. Figure 2 illustrates a method for providing one or more inducements to a user conducting an e-commerce transaction using an optimization process.

As shown, in step 202 the method may comprise receiving input from a user conducting an e-commerce transaction with an e-commerce vendor. For example, an e-commerce server 102 of the e-commerce vendor may receive the user input, wherein the user is conducting the e-commerce transaction with the e-commerce server 102. The user input may comprise the user selecting the e-commerce site, or the user browsing the site, e.g., the user selecting a product or viewing information about a product. The user input may also comprise the user entering

various user demographic information, or information to purchase a product. Thus the user input may occur during any part of the e-commerce transaction.

As noted above, an e-commerce transaction may include a portion, subset or all of any of various stages of a user purchase of a product from an e-commerce site, including selection of the e-commerce site, browsing of products on the e-commerce site, selection of one or more products from the e-commerce site, such as using a "shopping cart" metaphor, and purchasing the one or more products or "checking out". During any stage of the e-commerce transaction, the system and method of the present invention may operate to generate and display one or more inducements to the user. As used herein, the term "user" may refer to a customer, a potential customer, a business, an organization, or any other establishment.

The method may comprise the client system 106 providing identification of the user, such as to the e-commerce server 102. The method may also or instead comprise the client system 106 providing identification of the client system 106, such as a MAC ID or other identification, such as to the e-commerce server 102. The client system identification may then be used, such as by the e-commerce server 102 or another server, to determine the identity of the user and/or relevant demographic information of the user.

The client system 106 may provide identification using any of various mechanisms, such as cookies, digital certificates, or any other user identification method. For example, the client system 106 may provide a cookie which indicates the identity of the user or client system 106. The client system 106 may instead provide a digital certificate which indicates the identity of the user or client system 106. A digital certificate may reside in the client computer 106 and may be used to identify the client computer 106. In general, digital certificates may be used to authenticate the user and perform a secure transaction. When the user accesses the e-commerce site of the e-commerce server 102, the client system 106 may transmit its digital certificate to the e-commerce server 102. As an alternative to the use of digital certificates, a user access to an e-commerce site may include registration and the use of passwords by users accessing the site, or may include no user identification.

In step 204 the method may include storing, receiving or collecting information, wherein the information is related to the e-commerce transaction. For example, the method may use the received digital certificate or cookie from the client system to reference the user's demographic information, such as from a database. The various types of information related to the e-commerce transaction were discussed above. This information may be used to generate the one or more inducements, as well as to update stored information pertaining to the user. Where the information is financial information received from a user, the financial information may be verified.

For example, pertinent information may be retrieved via accessing an internal or separate database 108 or 110, respectively, for demographic information, historical profiles, inventory information, environmental information, competitor information, or other information "related to the e-commerce transaction". Here, a separate database may refer to a remote database 110 maintained by the e-commerce vendor, or a database 110 operated and/or maintained by a third party, e.g., an infomediary. Thus, the e-commerce server 102 may access information from its own database and/or a third party database. In one embodiment, the method may include collecting information during the e-commerce transaction, such as demographic information regarding the user or the user's navigation of the e-commerce site, often referred to as 'click flow'. This collected information may then be used, possibly in conjunction with other information, in generating the one or more inducements.

In one embodiment, the method may include collecting demographic information of the user during the e-commerce transaction, which may then be used to generate the one or more inducements. For example, upon registration and or during checkout, the user might be asked to supply demographic information, such as name, address, hobbies, memberships, affiliations, etc.

For another example, environmental information, such as geographic information, local weather conditions, traffic patterns, popular hobbies, etc, may be determined based on the user's address to display specific products suitable for conditions in the user's locale, such as rain gear during the wet season.

In one embodiment, in order for the e-commerce vendor to gain information about the user, the user may be presented with an opportunity to complete a survey, upon completion of which the user may receive an inducement, such as a discount toward current or future purchases. In this manner, stored user demographic information may be kept current.

In step 206 the method may generate one or more inducements in response to the information, wherein the generation of inducements uses an optimization process. In the preferred embodiment, the generation of the one or more inducements may comprise inputting the information into an optimization process, and the optimization process generating (e.g., selecting or creating) one or more inducements in response to the information. In the preferred embodiment, the optimization process uses constrained optimization techniques.

The optimization process preferably comprises inputting the information related to the e-commerce transaction into at least one predictive model to generate one or more action variables. The action variables preferably comprise predictive user behaviors corresponding to the information. The action variables, as well as other data, such as constraints and an objective function, may then be input into an optimizer, which then may generate the one or more inducements to be presented to the user.

In various embodiments, the predictive model may comprise one or more linear predictive models, and/or one or more non-linear predictive models. Non-linear predicitve models may of course include both continuous non-linear and non-continuous non-linear models. In one embodiment the predictive model may comprise one or more trained neural networks. One example of a trained neural network is described in U.S. Patent No. 5,353,207.

As is well known in the art, a neural network comprises an input layer of nodes, an output layer of nodes, and a hidden layer of nodes disposed therein, and weighted connections between the hidden layer and the input and output layers. In the preferred embodiment neural network used in the invention, the connections and the weights of the connections essentially contain a stored representation of the e-commerce system and the user's interaction with the e-commerce system.

The neural network may be trained using back propagation with historical data or any of several other neural network training methods, as would be familiar to one skilled in the art. The above-mentioned information, including results of previous transactions of the user responding to previous inducements, which may be collected during the e-commerce transaction, may be used to update the predictive model(s). The predictive model may be updated either in a batch mode, such as once per day or week, or in a real time mode, wherein the model(s) are updated continuously as new information is collected.

In one embodiment, designed experiments may be used to create the initial training data for a neural network model. When the system or method is initially installed on an e-commerce server, the method may present a range of inducements to a subset of users or customers. Their resultant behaviors to these inducement may be

recorded, and then combined with demographic and other data. This information may then be used as the initial training data for the neural network model. This process may be repeated at various times to update the model, as desired.

As noted above, the optimizer may receive one or more constraints, wherein the constraints comprise limitations on one or more resources, and may comprise functions of the action variables. Examples of the constraints include budget limits, number of inducements allowed per customer, value of an inducement, or total value of inducements dispensed. The optimizer may also receive an objective function, wherein the objective function comprises a function of the action variables and represents the goal of the e-commerce vendor. In one embodiment, the objective function may represent a desired commercial goal of the e-commerce vendor, such as maximizing profit, or increasing market share. As another example, if the user is a habitual customer of the e-commerce vendor, the objective function may be a function of lifetime customer value, wherein lifetime customer value comprises a sum of expected cash flows over the lifetime of the customer relationship.

The optimizer may then solve the objective function subject to the constraints and generate (e.g., select) the one or more inducements. The optimization process is described in greater detail below with respect to Figures 4 - 7.

After the optimizer generates one or more inducements in response to the information using the optimization process, in step 208 the method then provides the one or more generated inducements to the user. More specifically, the e-commerce server 102 (or the optimization server 112 or inducement server 122) provides the inducement(s) to the client computer system 106, where the inducements are displayed, preferably by a browser, on the client computer system 106. As discussed above, the inducement(s) are preferably designed to encourage or entice the user to complete the transaction in a desired way, such as by purchasing a product, purchasing additional products, selecting a particular e-commerce site, providing desired user demographic information, etc. In one embodiment, the one or more inducements are pre-selected and then provided to the user while the user conducts the e-commerce transaction. In another embodiment, the inducement(s) may be both selected and provided substantially in real time while the user is conducting the e-commerce transaction.

As one example, during user checkout to purchase a product from the e-commerce vendor, the one or more generated inducements are provided and displayed to the user on the client system 106 to encourage the user to complete the purchase. In response to the inducements provided and displayed to the user, the user may provide input to complete purchase of the product from the e-commerce vendor. The user input to complete purchase of the product from the e-commerce vendor may include acceptance of the one or more inducements. The e-commerce vendor would then provide the product to the user, incorporating any inducements or incentives made to the user, such as discounts, free gifts, discounted shipping etc.

As another example, the one or more generated inducements may be provided and displayed to the user while the user is browsing products on the e-commerce site to encourage or entice the user to purchase these products, e.g., to add the products to his/her virtual shopping cart. In response to the inducements provided and displayed to the user, the user may provide input to add products to his/her shopping cart. In one embodiment, the inducements that are made to encourage the user to add the products to his/her virtual shopping cart may only be valid if the products are in fact purchased by the user.

After the user has responded to the inducement, the method may include collecting information regarding the user's response to the particular inducement provided. This collected information may then be used to update or train the predictive model(s), e.g., to train the neural network(s). The collected information may include not only the particular inducement provided and the user's response, but also the timing of the inducement with respect to the user's navigation of the e-commerce site. The optimization process may then take this information into account in the future presentations of inducements to users, thus the types of inducements presented as well as the timing of inducement presentation may be optimized.

The above-mentioned information regarding the user's response to inducements may also be stored and compiled to generate summary displays and reports to allow the e-commerce vendor or others to review the results of inducement offerings. The summary displays and reports may include, but are not limited to, percentage responses of particular classes or segments of users to particular inducements presented at particular stages or times in the click-flow of the users' site navigation, revenue increases as a function of inducements, inducement timing, and/or user demographics, or any other information or correlations germane to the e-commerce vendor's goals.

In an alternate embodiment, the predictive model is a commerce model of a commerce system which is used to predict a defined commercial result as a function of information related to the e-commerce transaction and also as a function of the inducements that can be provided to the user during the commerce transaction. The optimal inducement is generated by varying the inducement input to the commerce model to vary the predicted output of the commerce model in a predetermined manner until a desired predicted output of the commerce model is achieved, at which point, the optimal inducement has been generated. In this embodiment, the predictive model is preferably a trained neural network.

Figure 3 - Optimized Configuration of an E-Commerce Site

Figure 3 is a flowchart diagram that illustrates one embodiment of the present invention. Figure 3 illustrates a method for configuring an e-commerce site using an optimization process. Here it is presumed that the e-commerce site is maintained by an e-commerce vendor, and that the e-commerce site is useable for conducting e-commerce transactions.

As shown, in step 302 the method comprises receiving vendor information, wherein the vendor information is related to products offered by the e-commerce vendor. As used herein, the vendor information may include an inventory of products offered by the e-commerce vendor, time and date information, environmental information, and/or competitive information of competitors to the e-commerce vendor. The vendor information is preferably not specific to any one user, but rather is related generally to the e-commerce vendor's products, web site or other general information. In one embodiment, the vendor information may include user-specific information, which may entail customizing portions of the e-commerce site for specific users.

In one example, the vendor information may include inventory information pertaining to which of the e-commerce vendor's products are over-stocked, so that they may be featured prominently on the e-commerce site or placed on sale, and/or those that are under-stocked or sold out, so that the price may be adjusted or selectively removed.

In another example, the vendor information may comprise seasonal and/or cultural information, such as the beginning and end of the Christmas season, or Cinco de Mayo, whereupon appropriate marketing and/or graphical themes may be presented.

In yet another example, the vendor information may involve competitive information of competitors, such as the competitor's current pricing of products identical to or similar to those sold by the e-commerce vendor. The e-commerce vendor's prices may then be adjusted, or product presentation may be changed.

The method may also include receiving or collecting customer information, wherein the customer information is related to a plurality or all of the customers or potential customers of the e-commerce vendor.

The vendor information may be used alone or in conjuction with the customer information. Alternatively, the customer information may be used alone or in conjuction with the vendor information.

In step 304 the method includes generating a configuration of the e-commerce site in response to one or more of the vendor information and the customer information, wherein generation of the e-commerce site configuration uses an optimization process. In one embodiment, generating the configuration of the e-commerce site includes modifying one or more configuration parameters of the e-commerce site and/or generating one or more new configuration parameters of the e-commerce site. For example, one or more configuration parameters of the e-commerce site may represent one or more of a color or a layout of the e-commerce site. One or more configuration parameters of the e-commerce site may also represent content comprised in or presented by the e-commerce site, such as text, images, graphics, audio, or other types of content. One or more configuration parameters of the e-commerce site may also represent one or more inducements, such as promotions, advertisements, offers, or product purchase discounts or incentives, in the e-commerce site, as described above with respect to Figure 2.

The optimization process used to generate the e-commerce site configuration is described above with reference to Figure 2, but in this embodiment of the invention, the information input into the predictive model is the vendor information and/or the customer information, and the optimized decision variables comprise the e-commerce site configuration parameters. Examples of the constraints in this embodiment may comprise the number of products displayed, the number of colors employed simultaneously on the page, or limits on the values of sale discounts. The objective function represents a given desired commercial goal of the e-commerce vendor, such as increased profits, increased sales of a particular product or product line, increased traffic to the e-commerce site, etc. Further detailed description of the optimization process may be found below, with reference to Figures 4-7.

Once the optimizer has solved the objective function, in step 306, the resulting configuration parameters are applied to the e-commerce site. In other words, the e-commerce site is configured, modified or generated based on the configuration parameters produced by the optimization process. Thus a designer may change one or more of a color, layout or content of the e-commerce site. In an alternate embodiment, the optimized configuration parameters may be applied to the e-commerce site automatically by software designed for that purpose which may reside on the e-commerce server. In this way, the e-commerce site may in large part be configured without the need for direct human involvement.

For example, modification of one or more configuration parameters of the e-commerce site may entail modifying one or more of a color or a layout of the e-commerce site. Modification of one or more configuration

parameters of the e-commerce site may also entail modifying content comprised in or presented by the e-commerce site, such as text, images, graphics, audio, or other types of content. Modification of one or more configuration parameters of the e-commerce site may also include incorporating one or more inducements, such as promotions, advertisements, or product purchase discounts or incentives, in the e-commerce site in response to the vendor information, as described above with respect to Figure 2.

In step 308 the method includes making the reconfigured e-commerce site available to users of the e-commerce site. In other words, when users connect to the e-commerce site, the newly configured e-commerce pages are provided to the user and displayed on the client system of the user. These newly configured e-commerce pages are designed to achieve a desired commercial goal of the e-commerce vendor.

It should be noted that, although the embodiments illustrated in Figures 2 and 3 have much in common, they differ in the following way. The inducement optimization embodiment of Figure 2 is preferably executed with the aim of influencing an individual user by customizing the inducements which may be based primarily on information specific to that user, or to a user segment or sample of which that user is a member. In contrast, the configuration optimization embodiment of Figure 3 is preferably executed with the aim of influencing a broad group of users based primarily on information, circumstances, and needs of the e-commerce vendor. Alternatively, the configuration optimization embodiment of Figure 3 may be executed with the aim of influencing a broad group of users based at least in part on demographics, past transactions, or other information of a plurality of customers or potential customers.

It should be noted that the embodiments of Figures 2 and 3 are not mutually exclusive, and so may be used in conjunction with each other to further the commercial goals of the e-commerce vendor.

Figures 4 through 7: Overview of Optimization

As discussed herein, optimization may generally be used by a decision-maker associated with a business to select an optimal course of action or optimal course of decision. The optimal course of action or decision may include a sequence or combination or actions and/or decisions. For example, optimization may be used to select an optimal course of action for marketing one or more products to one or more customers, e.g., by selecting inducements or web site configuration for an e-commerce site. As used herein, a "customer" may include an existing customer or a prospective customer of the business. As used herein, a "customer" may include one or more persons, one or more organizations, or one or more business entities. As used herein, the term "product" is intended to include various types of goods or services, as described above. As will be apparent to one skilled in the art, the system and method for optimization described herein may be applied to a wide variety of industries and circumstances.

Generally, a business may desire to apply the optimal course of action or optimal course of decision to one or more customer relationships to increase the value of customer relationships to the business. As used herein, a "portfolio" includes a set of relationships between the business and a plurality of customers. In general, the process of optimization may include determining which variables in a particular problem are most predictive of a desired outcome, and what treatments, actions, or mix of variables under the decision-maker's control (i.e., decision variables) will optimize the specified value. The one or more products may be marketed to customers in accordance with the optimal course of action, such as through inducements displayed on an e-commerce site, or an

optimized web site configuration. Other means of applying the optimal course of action may include, for example, direct mailing and/or targeted advertising, conducting a re-pricing campaign in accordance with the optimal course of action, conducting an acquisition campaign in accordance with the optimal course of action, conducting an e-mailing campaign in accordance with the optimal course of action, and conducting a promotional campaign in accordance with the optimal course of action.

Figure 4a is a block diagram which illustrates an overview of optimization according to one embodiment. Figure 4b is a dataflow diagram which illustrates an overview of optimization according to one embodiment. As shown in Figure 4a, an optimization process 400 may accept the following elements as input: customer information records 402, predictive model(s) such as customer model(s)404, one or more constraints 406, and an objective 408. The optimization process 400 may produce as output an optimized set of decision variables 410. In one embodiment, each of the customer model(s) 404 may correspond to one of the customer information records 402. As used herein, an "objective" may include a goal or desired outcome of an optimization process.

As used herein, a "constraint" may include a limitation on the outcome of an optimization process. Constraints are typically "real-world" limits on the decision variables and are often critical to the feasibility of any optimization solution. Constraints may not be limited to decision variables, but may be also be constraints of action variables. Managers who control resources and capital or are responsible for financial effects should be involved in setting constraints that accurately represent their real-world environments. Setting constraints with management input may realistically restrict the allowable values for the decision variables.

In many applications of the optimization process 400, the number of customers involved in the optimization process 400 may be so large that treating the customers individually is computationally infeasible. In these cases, it may be useful to group like customers together in segments. If segmented properly, the customers belonging to a given segment will typically have approximately the same response in the action variables to a given change in decision variables and external variables. For example, customers may be placed into particular segments based on particular customer attributes such as risk level, financial status, or other demographic information. Each customer segment may be thought of as an average customer for a particular type or profile. A segment model, which represents a segment of customers, may be used as described above with reference to a customer model 404 to generate the action variables for that segment. Another alternative to treating customers individually is to sample a larger pool of customers. Therefore, as used herein, a "customer" may include an individual customer, a segment of like customers, and/or a sample of customers. As used herein, a "customer model", "predictive model", or "model" may include segment models, models for individual customers, and/or models used with samples of customers.

The customer information 402 may include decision variables 414 and external variables 412. As used herein, "decision variables" are those variables that the decision-maker may change to affect the outcome of the optimization process 400. For example, in the optimization of inducements provided to a user viewing an e-commerce site, the type of inducement and value of inducement may be decision variables. As used herein, "external variables" are those variables that are not under the control of the decision-maker. In other words, the external variables are not changed in the decision process but rather are taken as givens. For example, external variables may include variables such as customer addresses, customer income levels, customer demographic information, bureau data, transaction file data, cost of funds and capital, and other suitable variables.

In one embodiment, the customer information 402 including decision variables 414 and external variables 412 may be input into the predictive model(s) 416 to generate the action variables 418. In one embodiment, each of the predictive model(s) 416 may correspond to one of the customer information records 402, wherein each of the customer information records 402 may include appropriate decision variables 414 and external variables 412. As used herein, "action variables" are those variables that predict a set of actions for an input set of decision and external variables. In other words, the action variables may comprise predictive metrics for customer behavior. For example, in the optimization of inducements provided to users, the action variables may include the probability of a customer's response to an inducement. In a re-pricing campaign, the action variables may include the likelihood of a customer maintaining a service after re-pricing the service. In the optimization of a credit card offer, the action variables may include predictions of balance, attrition, charge-off, purchases, payments, and other suitable behaviors for the customer of a credit card issuer.

The predictive model(s) 416 may include the customer model(s) 404 as well as other models. The predictive model(s) 416 may take any of several forms, including, but not limited to: trained neural nets, statistical models, analytic models, and any other suitable models for generating predictive metrics. The models may take various forms including linear or non-linear, such as a neural network, and may be derived from empirical data or from managerial judgment.

In one embodiment, the predictive model(s) 416 may be implemented as a neural network. Typically, the neural network may include a layer of input nodes, interconnected to a layer of hidden nodes, which are in turn interconnected to a layer of output nodes, wherein each connection is associated with an adjustable weight whose value is set in the training phase of the model. The neural network may be trained, for example, with historical customer data records as input. The trained network may include a non-linear mapping function that may be used to model customer behaviors and provide predictive customer models in the optimization system. The trained neural network may generate action variables 418 based on customer information 402 such as external variables 412 and decision variables 414.

In one embodiment, a model comprises a representation that allows prediction of action variables, a, due to various decision variables, d, and external variables, e. Figure 5 illustrates a model 415 with external variables 412, decision variables 414, and resulting action variables 418. For example, a customer may be modeled to predict customer response to various offers under various circumstances. It may be said that the action variables, a, are a function, via the model, of the decision and external variables, d and e, such that:

$$a = M(d, e) \tag{1}$$

wherein $M()$ is the model, a, is the vector of action variables, d is the vector of decision variables, and e is the vector of external variables.

In one embodiment, the action variables 418 generated by the model(s) 416 may be used to formulate constraint(s) 406 and the objective function 408 via formulas. In Figure 4b, a data calculator 420 generates the constraint(s) and objective 422 using the action variables 418 and potentially other data and variables. In one embodiment, the formulas used to formulate the constraint(s) and objective 422 may include financial formulas such as formulas for determining net operating income over a certain time period. The constraint(s) and objective 422 may be input into an optimizer 424, which may comprise, for example, a custom-designed process or a

commercially available "off the shelf" product. The optimizer may then generate the optimal decision variables 410 which have values optimized for the goal specified by the objective function 408 and subject to the constraint(s) 406. The optimization process 400 carried out by the optimizer 424 is discussed in greater detail below. A further understanding of the optimization process 400 may be gained from the references "An Introduction to Management Science: Quantitative Approaches to Decision Making", by David R. Anderson, Dennis J. Sweeney, and Thomas A. Williams, West Publishing Co. (1991); and "Fundamentals of Management Science" by Efraim Turban and Jack R. Meredith, Business Publications, Inc. (1988).

Overview of Optimization for a Single Customer

Many optimization problems have the following form: given a model of a customer or segment $a = M(d,e)$, a set of objective parameters o, a set of constraint parameters c_p, and a set of constraint bounds c_b, use an optimizer to compute the set of decision variables for a customer or segment that extremizes (e.g., maximizes or minimizes) an objective function of the form:

$$J = f(d,e,a,o) \tag{2}$$

subject to the model constraint:

$$a = M(d,e) \tag{1}$$

and a general set of constraints of the form:

$$0 \le g(d,e,a,c_p) \le c_b \tag{3}$$

wherein the decision variables d, are a subset of the set of possible decision variables, D.

There are a number of approaches for solving optimization problems of this form. As is well known by those skilled in the art, the approach selected depends on the form of the model, of the objective function, of the constraints, and of the set of possible decision variables. The model, objective function, and constraints may each be either linear (L) or non-linear (NL). The decision variable set, D, may be a linearly bounded single region (simple convex area) (L), a non-linear bounded single region (NL), multiple regions (MR), or discrete. Commercial solvers, or optimizers, are available for solving all combinations of linear and non-linear components for single region decision variable sets. For the cases when variables are not restricted to a single continuous region, a variety of other, more heuristic, approaches are generally available. Several of these approaches solving optimization problems are discussed in greater detail as follows.

Example of Optimization with Linear Programming

A simple credit card offer optimization problem illustrates the LP approach. The model computes the response rate to a mailed offer and expected monthly balance of a responder: therefore, the action variables are: a_1 = response rate; a_2 = expected balance. The decision variables for the offer are annual percentage rate (APR) and

credit limit: thus. d_1 = APR; d_2 = credit limit. There are no external variables in this example.

A linear model of the form:

$$a_1 = w_{11}d_1 + w_{12}d_2 + b_1$$
$$a_2 = w_{21}d_1 + w_{22}d_2 + b_2 \quad (4)$$

may be used. wherein w_{11}, w_{12}, b_1, w_{21}, w_{22}, and b_2 are parameters of the model. The parameters may be found. for example. using linear regression techniques based upon historical data.

The objective function. J, to be maximized. also linear. is of the form:

$$J = o_1a_1 + a_2 \quad (5)$$

wherein o_1 is an optimization parameter. Using this objective function, a_1 and a_2 may be maximized. The relative importance of a_1 versus a_2 is determined by the optimization parameter, o_1, which is specified by the user.

A linear constraint is of the form:

$$0 \le c_{p,1}a_1 + a_2 \le c_{b,1} \quad (6)$$

and the set of possible decision variables, D, is restricted such that:

$$.05 \le d_1 \le .19 \quad \text{(range of APR)} \quad (7)$$
$$1{,}000 \le d_2 \le 5{,}000 \quad \text{(range of credit limit)} \quad (8)$$

Because the model, objective function, constraint, and set of decision variables are linear. this example can be solved using standard linear programming techniques.

Example of Optimization with Non-Linear Programming

In a further example. the objective, constraints, and set of decision variables are of the form shown above, and the model is implemented by a non-linear neural network:

$$a = M(d,e) = NN(d,e,w) \quad (9)$$

wherein w is the vector of weight parameters of the neural network which may be identified using historical data and the back propagation method of neural network training. In this case. because the model is non-linear. a non-linear commercial solver/optimizer may be used to solve for the decision variables.

Overview of Optimization with Heuristic Linear Programming

A similar problem may be considered, but with the set of possible decision variables restricted to a discrete set, such as:

$$\begin{bmatrix} d_1 \\ d_2 \end{bmatrix} \in \left(\begin{bmatrix} .05 \\ 1000 \end{bmatrix}, \begin{bmatrix} .09 \\ 1000 \end{bmatrix}, \begin{bmatrix} .125 \\ 2500 \end{bmatrix}, \begin{bmatrix} .19 \\ 5000 \end{bmatrix} \right) \tag{10}$$

such that the APR values of each of the four offers are 5%, 9%, 12.5%, and 19%, respectively, and the credit limits are $1000, $1000, $2500, and $5000, respectively. Because the problem is non-linear and discrete, a mixed integer linear programming (MILP) approach may be used; however, by reformulating the problem heuristically, a linear programming (LP) technique may be used instead. This is referred to as a heuristic LP approach.

The above problem may be reformulated by enumerating the solutions, e.g., by computing the output of the neural network model for each element of the set:

$$\begin{bmatrix} a_1 \\ a_2 \end{bmatrix} \in \left(NN(.05,1000), NN(.09,1000), NN(.125,2500), NN(.19,5000) \right) = \tag{11}$$

$$\left(\begin{bmatrix} a_{11} \\ a_{21} \end{bmatrix}, \begin{bmatrix} a_{12} \\ a_{22} \end{bmatrix}, \begin{bmatrix} a_{13} \\ a_{23} \end{bmatrix}, \begin{bmatrix} a_{14} \\ a_{24} \end{bmatrix} \right)$$

wherein the output corresponding to the first element of the set is $\begin{bmatrix} a_{11} \\ a_{21} \end{bmatrix}$. The objective function, J, may then be rewritten to select the optimal pair of action variables:

$$\max J = n_1(o_1 a_{11} + a_{21}) + n_2(o_2 a_{12} + a_{22}) + n_3(o_3 a_{13} + a_{23}) + n_4(o_4 a_{14} + a_{24}) \tag{12}$$

wherein n_i are selection variables constrained by:

$$0 \le n_i \le 1 \tag{13}$$

$$\sum_{i=1}^{4} n_i = 1 \tag{14}$$

and wherein:

$$0 \le c_{p,1} a_1 + a_2 \le c_{b,1} \tag{6}$$

At this point, a conventional linear programming technique may be used because the selection variables n_i are optimized, rather than the decision variables, and because n_i appear linearly. Once the optimal selection variables are computed, one of the n_i will be equal to 1, with the rest equal to 0, assuming only one maximum in the set. The optimal decision variables of the set correspond to the n_i equal to 1. Thus, the decision variables are computed using a heuristic LP approach. This technique may generally be used when the set of discrete decision variables is finite.

Overview of Optimization for Multiple Products or Multiple Customers

In the cases where multiple products may be offered to a single customer, or where a single product may be offered to multiple customers, a different model may be used for each product/customer pair. For example, in the case of a single customer being offered multiple products, the models may be defined as follows:

$$a_1 = M(d_1, e_1),\ a_2 = M(d_2, e_2), \ldots,\ a_m = M(d_m, e_m) \tag{15}$$

with a set of Boolean selection variables:

$$s = (s_1, s_2, \ldots s_m) \tag{16}$$

that may be used to select which offers to make to the customer. Figure 6 illustrates the multiple product models of expression (15).

In a similar way, for the case of a single product being offered to multiple customers, the models may be defined as follows:

$$a_1 = M(d_1, e_1),\ a_2 = M(d_2, e_2), \ldots,\ a_N = M(d_N, e_N) \tag{17}$$

with a set of Boolean selection variables:

$$s = (s_1, s_2, \ldots s_N) \tag{18}$$

Figure 7 illustrates these multiple customer models. Optimization with multiple customer models is mathematically equivalent to optimization with multiple product models.

Given the above set of models for various products $M \in (M_1, M_2, \ldots, M_m)$ for a customer (i.e., an individual customer, customer segment, or customer sample), a set of objective parameters o, a set of constraint parameters c_p, a set of constraint bounds c_b, and an objective function of the form:

$$J = f(d_1, e_1, a_1, s_1, d_2, e_2, a_2, s_2, \ldots d_m, e_m, a_m, s_m, o) \quad (19)$$

which is subject to the model constraints:

$$a_1 = M(d_1, e_1),\ a_2 = M(d_2, e_2), \ldots,\ a_m = M(d_m, e_m) \quad (15)$$

and a general set of constraints of the form:

$$0 \le g(d_1, e_1, a_1, s_1, d_2, e_2, a_2, s_2, \ldots d_m, e_m, a_m, s_m, c_p) \le c_b \quad (20)$$

and the set of possible decision variables, D, and selection variables, S, such that:

$$d \in D \quad (21)$$
$$s \in S$$

then an optimizer may generally be used to compute the decision variables for a customer to extremize the objective function, J.

Figures 8: Closed-Loop Software Architecture for E-Commerce

Figure 8 illustrates a closed-loop software architecture for performing e-commerce transactions according to one embodiment. Figure 8 illustrates an example of an architecture for a closed-loop system for making marketing decisions concerning e-commerce. The architecture shown in Figure 8 may be applied in other circumstances for different external systems and different on-line applications.

An Internet business may use the architecture shown in Figure 8 to make decisions and perform experiments on the contents of inducements, such as promotions and incentives to be delivered via e-mail or displayed on web pages. In the example software architecture shown in Figure 8, the Export module 2150 may be customized with a set of transformations 2120 and a Data Interface sub-module that converts the experiment and decision data to an e-mail delivery system. The combination may create e-mail messages that contain the inducement, such as a promotion or incentive, which may be tailored to the customer. The e-mail messages may be sent through an E-mail Touch-Point 2220. The Import module 2100 may be customized with a set of transformations 2120 and Data Interface sub-modules that convert the data from Third Party Customer Data Warehouses 2230 and an internal Data Collection database 2800. The Data Collection database 2800 may be used to store the results from the e-mail and web responses. Another version of the Import module 2100 may be customized with a set of transformations 2120 and a Data Interface sub-module 2130 that converts the e-mail responses from an e-mail delivery system such as E-mail Touch-Point 2220 for the Data Collection database 2800. The off-line modules may also be used to run simulations for the on-line modules. Once the simulations prove satisfactory, the transformations 2120, rules 2330, and predictive models 2510 used in the simulations may be deployed to the on-line modules.

Figure 9: Flowchart for Web Touch-point Application

Figure 9 is a flowchart illustrating a method that may be used by the Web Touch-point Application 2260 according to one embodiment. In step 2900, the Web Touch-point Application 2260 may call the Web On-line Interface module 2700 to get an inducement, such as a promotion or incentive. The Web Touch-Point Application 2260 may be coupled to a Web Server 2250 which may be coupled to a Web Browser 2240. The Web On-line Interface module 2700 may be coupled to the various Data Transformation Engines (DTEs) 2110, Decision Engine 2640, Experiment Engine 2340, and databases as shown in Figure 9.

In step 2902, the Web On-line Interface module 2700 may collect the customer data known by the Web Touch-point Application 2260. In step 2904, the Web On-line Interface module 2700 may retrieve additional customer data from the Third Party Customer Database 2230. In step 2906, the Web On-line Interface module 2700 may determine whether an experiment or decision should be performed. In step 2908, the Web On-line Interface module 2700 may use the on-line APIs 2110, 2640, 2340 to determine the tailored inducement. In step 2910, the Web On-line Interface module 2700 may record the inducement in the Data Collection database 800. In step 2912, the Web On-line Interface module 2700 may return the tailored inducement to the Web Touch-point Application 2260. In step 2914, the Web Touch-point Application 2260 may call the Web On-line Interface module 2700 to record response information. In step 2916, the Web On-line Interface module 2700 may record the response information in the Data Collection database 800.

In one embodiment, the Web On-line Interface module 2700 may be implemented such that the Web On-line Interface module 2700 and the on-line APIs 2110, 2640, 2340 may reside on the same computer as the Web Touch-point Application 2260. The databases 230, 800 may each be hosted on a remote computer, separate from the computer running the Web On-line Interface module 2700. The data elements collected in the Data Collection database 800 may be used in the off-line modules to adapt the models and experiments to make further adjustments in the e-mail and web inducements.

Although the system and method of the present invention has been described in connection with the preferred embodiment, it is not intended to be limited to the specific form set forth herein, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents, as can be reasonably included within the spirit and scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A method for configuring an electronic commerce site, wherein the electronic commerce site is maintained by an electronic commerce vendor, wherein the electronic commerce site is useable for conducting electronic commerce transactions, the method comprising:

receiving vendor information, wherein the vendor information is related to products offered by the electronic commerce vendor; and

generating a configuration of the electronic commerce site in response to the vendor information, wherein said generating uses an optimization process.

2. The method of claim 1, wherein the optimization process uses constrained optimization techniques.

3. The method of any of the preceding claims, wherein said generating the configuration of the electronic commerce site comprises:

inputting the vendor information into an optimizer; and

the optimizer generating one or more configuration parameters of the electronic commerce site in response to the vendor information;

wherein the one or more configuration parameters are used to generate the configuration of the electronic commerce site.

4. The method of claim 3, wherein said generating one or more configuration parameters of the electronic commerce site comprises:

inputting the vendor information into at least one predictive component model to generate one or more component values, wherein the component values comprise predictive user behaviors corresponding to the information;

inputting one or more constraints into the optimizer, wherein the constraints comprise limitations on one or more resources;

inputting an objective function into the optimizer, wherein the objective function comprises a function of the component values;

the optimizer solving the objective function subject to the constraints;

wherein the optimizer generates the one or more configuration parameters of the electronic commerce site based on the solved objective function.

5. The method of claim 4, wherein the at least one predictive component model comprises at least one trained neural net.

6. The method of claim 3. wherein the vendor information comprises a plurality of data records:

wherein each data record corresponds to an inventory of one or more products of the electronic commerce vendor.

7. The method of claim 3. wherein the vendor information comprises a plurality of data records:

wherein each data record corresponds to a segment. wherein the segment comprises an inventory of a plurality of products of the electronic commerce vendor.

8. The method of claim 3. wherein the information comprises a plurality of data records;

wherein each data record corresponds to a sample of an inventory of one or more products of the electronic commerce vendor.

9. The method of claim 3. wherein said generating one or more configuration parameters of the electronic commerce site comprises:

inputting the vendor information into at least one trained neural network to generate one or more component values, wherein the component values comprise predictive user behaviors corresponding to the information;

inputting one or more constraints into the optimizer. wherein the constraints comprise limitations on one or more resources;

inputting an objective function into the optimizer. wherein the objective function comprises a function of the component values;

the optimizer solving the objective function subject to the constraints;

wherein the optimizer generates the one or more configuration parameters of the electronic commerce site based on the solved objective function;

the method further comprising:

training the neural network using historical information to produce the trained neural net.

10. The method of any of the preceding claims, wherein said generating the configuration of the electronic commerce site includes modifying one or more configuration parameters of the electronic commerce site.

11. The method of claim 10. wherein said modifying one or more configuration parameters of the electronic commerce site includes selecting one or more new configuration parameters of the electronic commerce site.

12. The method of claim 10. wherein said modifying one or more configuration parameters of the electronic commerce site includes modifying one or more of a color or a layout of the electronic commerce site.

13. The method of claim 10. wherein said modifying one or more configuration parameters of the electronic commerce site includes modifying content comprised in the electronic commerce site.

14. The method of claim 13, wherein said modifying one or more configuration parameters of the electronic commerce site includes modifying one or more images comprised in the electronic commerce site.

15. The method of claim 13, wherein said modifying one or more configuration parameters of the electronic commerce site includes modifying audio presented by the electronic commerce site.

16. The method of claim 10, wherein said generating the configuration of the electronic commerce site includes incorporating one or more offers in the electronic commerce site in response to the vendor information.

17. The method of claim 10, wherein said generating the configuration of the electronic commerce site includes incorporating one or more promotions in the electronic commerce site in response to the vendor information.

18. The method of claim 10, wherein said generating the configuration of the electronic commerce site includes incorporating one or more advertisements in the electronic commerce site in response to the vendor information.

19. The method of claim 10, wherein said generating the configuration of the electronic commerce site includes incorporating one or more product purchase discounts in the electronic commerce site in response to the vendor information.

20. The method of any of the preceding claims, wherein the vendor information includes an inventory of products offered by the electronic commerce vendor.

21. The method of any of the preceding claims, wherein the vendor information includes a time and date.

22. The method of any of the preceding claims, wherein the vendor information includes competitive information of competitors to the electronic commerce vendor.

23. The method of any of the preceding claims, further comprising:
configuring the electronic commerce site according to the generated configuration.

24. The method of claim 23, further comprising:
providing the electronic commerce site to one or more clients after said configuring.

25. The method of any of the preceding claims, further comprising:

receiving customer information, wherein the customer information is related to current or prospective customers of the electronic commerce vendor; and

wherein said generating comprises generating the configuration of the electronic commerce site in response to the vendor information and the customer information, wherein said generating uses an optimization process.

26. A carrier medium comprising program instructions, wherein the program instructions are executable by a computer system to implement a method according to any of claims 1 through 25.

27. A system for configuring an electronic commerce site, wherein the system performs a method according to any of claims 1 through 25.

28. A system for configuring an electronic commerce site, wherein the electronic commerce site is maintained by an electronic commerce vendor, wherein the electronic commerce site is useable for conducting electronic commerce transactions, the system comprising:

a database storing vendor information, wherein the vendor information is related to products offered by the electronic commerce vendor; and

an optimization program which is executable to generate a configuration of the electronic commerce site in response to the vendor information, wherein the optimization program uses optimization techniques.

29. A method for configuring an electronic commerce site, wherein the electronic commerce site is maintained by an electronic commerce vendor, wherein the electronic commerce site is useable for conducting electronic commerce transactions, the method comprising:

receiving one or more of 1) vendor information or 2) customer information, wherein the vendor information is related to products offered by the electronic commerce vendor, wherein the customer information is related to current or prospective customers of the electronic commerce vendor; and

generating a configuration of the electronic commerce site in response to one or more of the vendor information or the customer information, wherein said generating uses an optimization process.

30. A method for providing one or more inducements to a user conducting an electronic commerce transaction, the method comprising:

receiving input from a user conducting an electronic commerce transaction with an electronic commerce vendor;

receiving information, wherein the information is related to the electronic commerce transaction;

generating one or more inducements in response to the information, wherein said generating uses an optimization process; and

providing the one or more inducements to the user during the electronic commerce transaction.

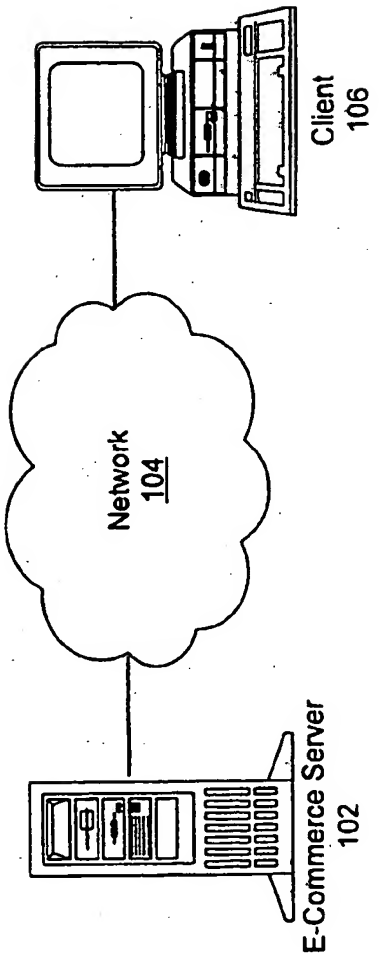

FIG. 1

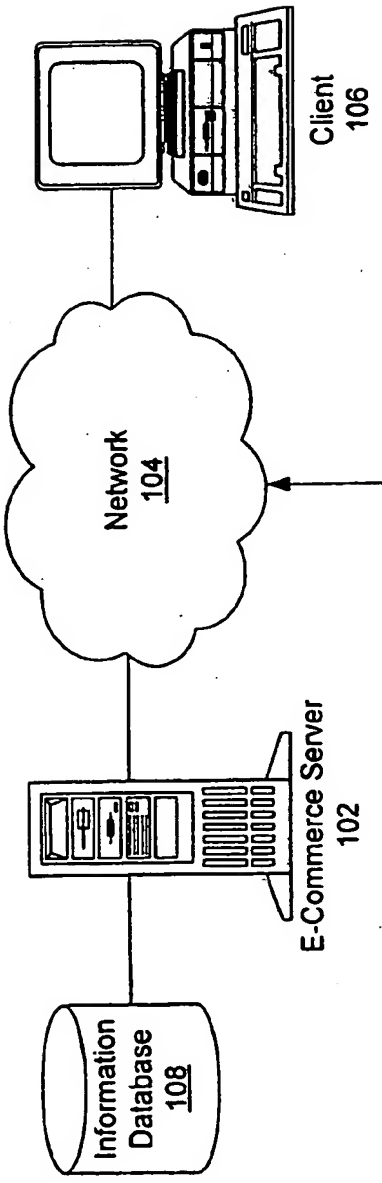
Client
106
Network
104
Database Server
110
E-Commerce Server
102
Information
Database
108

FIG. 1a

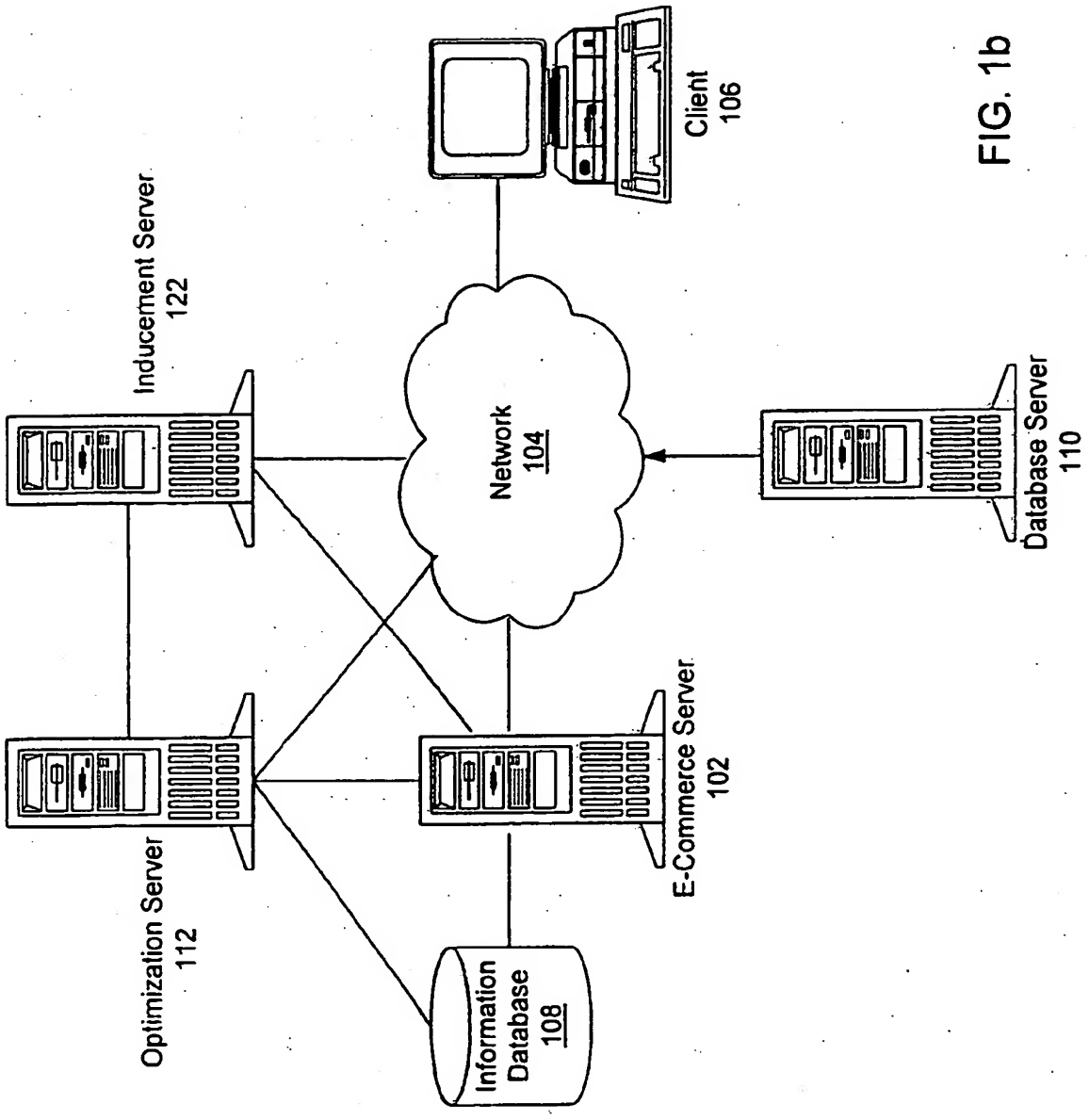
Client
106
Inducement Server
122
Network
104
Database Server
110
Optimization Server
112
E-Commerce Server
102
Information
Database
108

FIG. 1b

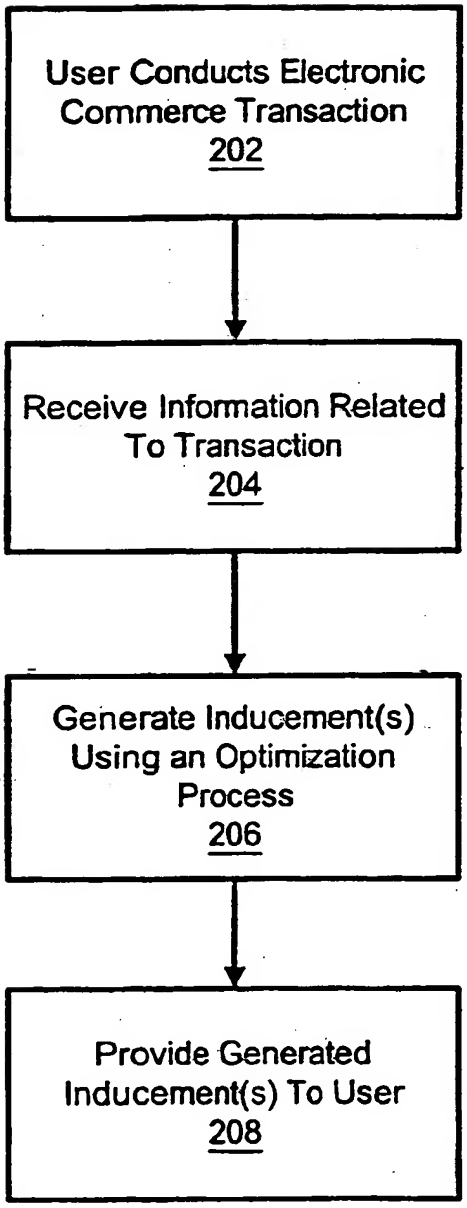
User Conducts Electronic Commerce Transaction
202
Receive Information Related To Transaction
204
Generate Inducement(s) Using an Optimization Process
206
Provide Generated Inducement(s) To User
208

Fig. 2

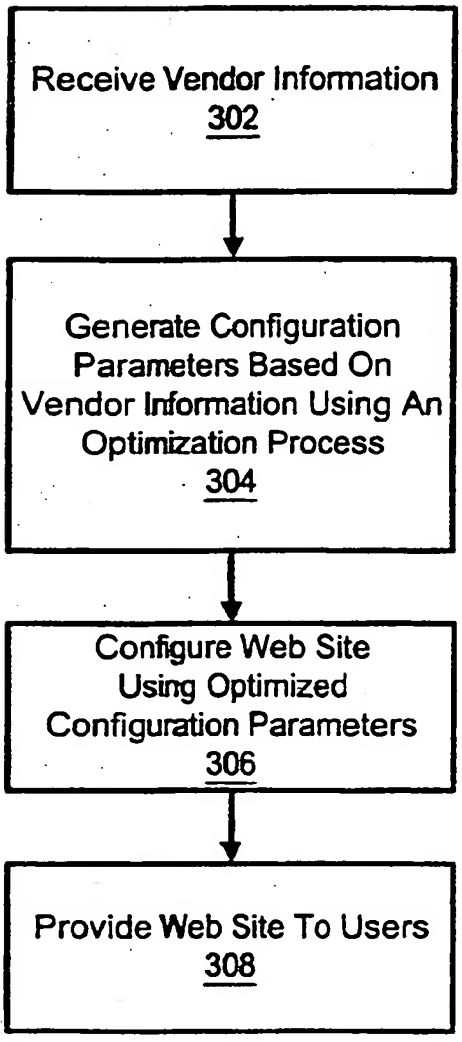
Receive Vendor Information
302
Generate Configuration Parameters Based On Vendor Information Using An Optimization Process
304
Configure Web Site Using Optimized Configuration Parameters
306
Provide Web Site To Users
308

Fig. 3

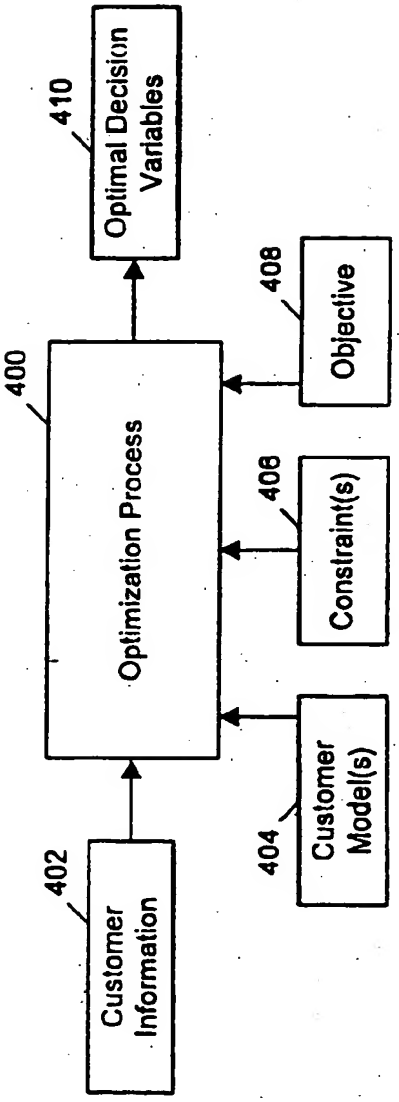
Customer Information
402
Optimization Process
400
Customer Model(s)
404
Constraint(s)
406
Objective
408
Optimal Decision Variables
410

FIG. 4a

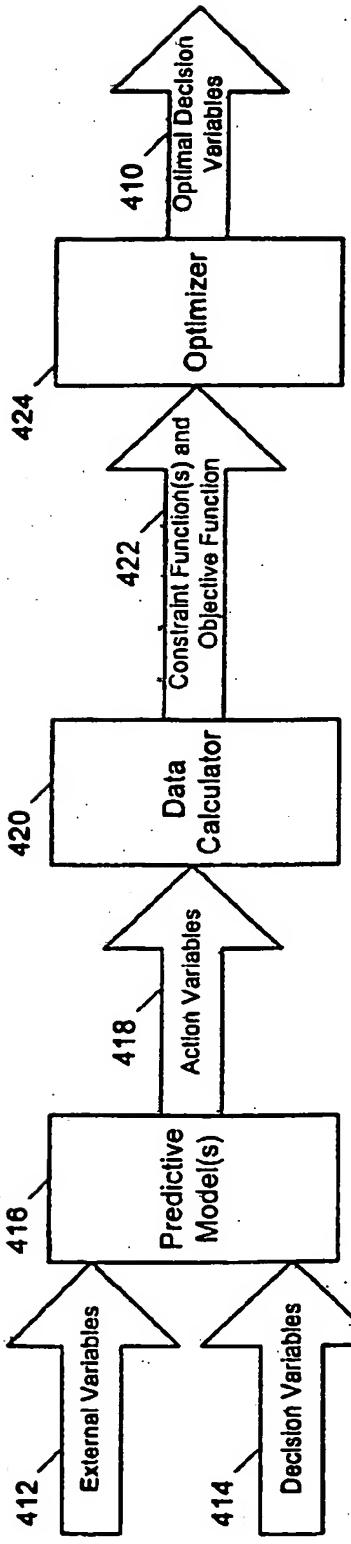
External Variables
412
Decision Variables
414
Predictive Model(s)
416
Action Variables
418
Data Calculator
420
Constraint Function(s) and Objective Function
422
Optimizer
424
Optimal Decision Variables
410

FIG. 4b

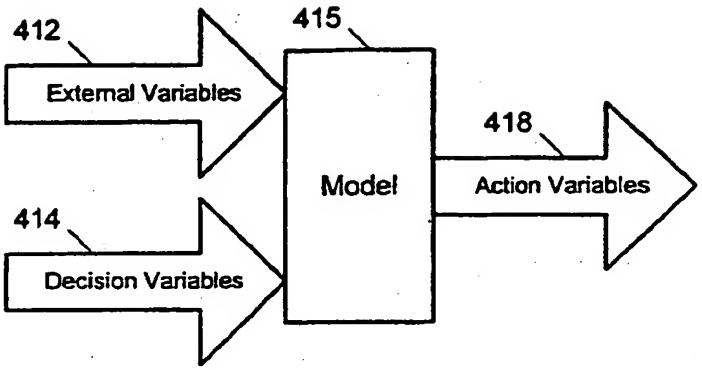
412
External Variables
414
Decision Variables
415
Model
418
Action Variables

FIG. 5

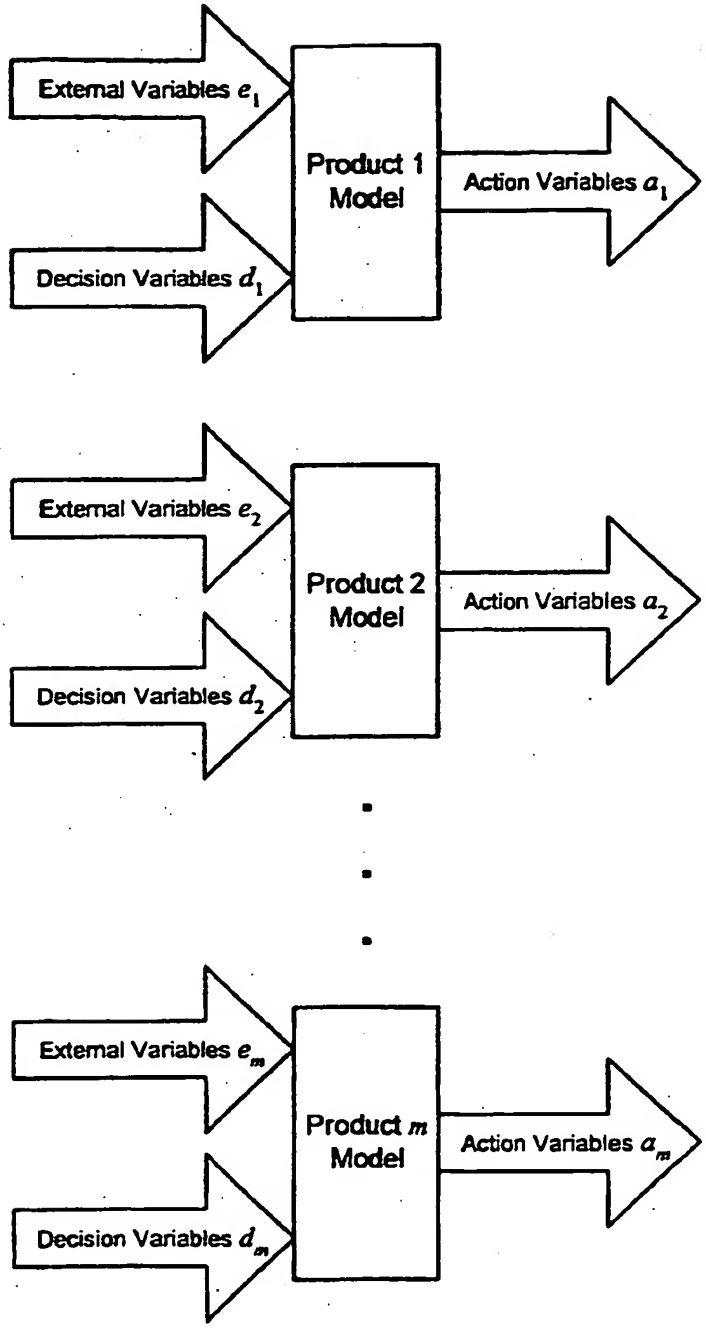
External Variables e_1
Decision Variables d_1
Product 1 Model
Action Variables a_1
External Variables e_2
Decision Variables d_2
Product 2 Model
Action Variables a_2
External Variables e_m
Decision Variables d_m
Product m Model
Action Variables a_m

FIG. 6

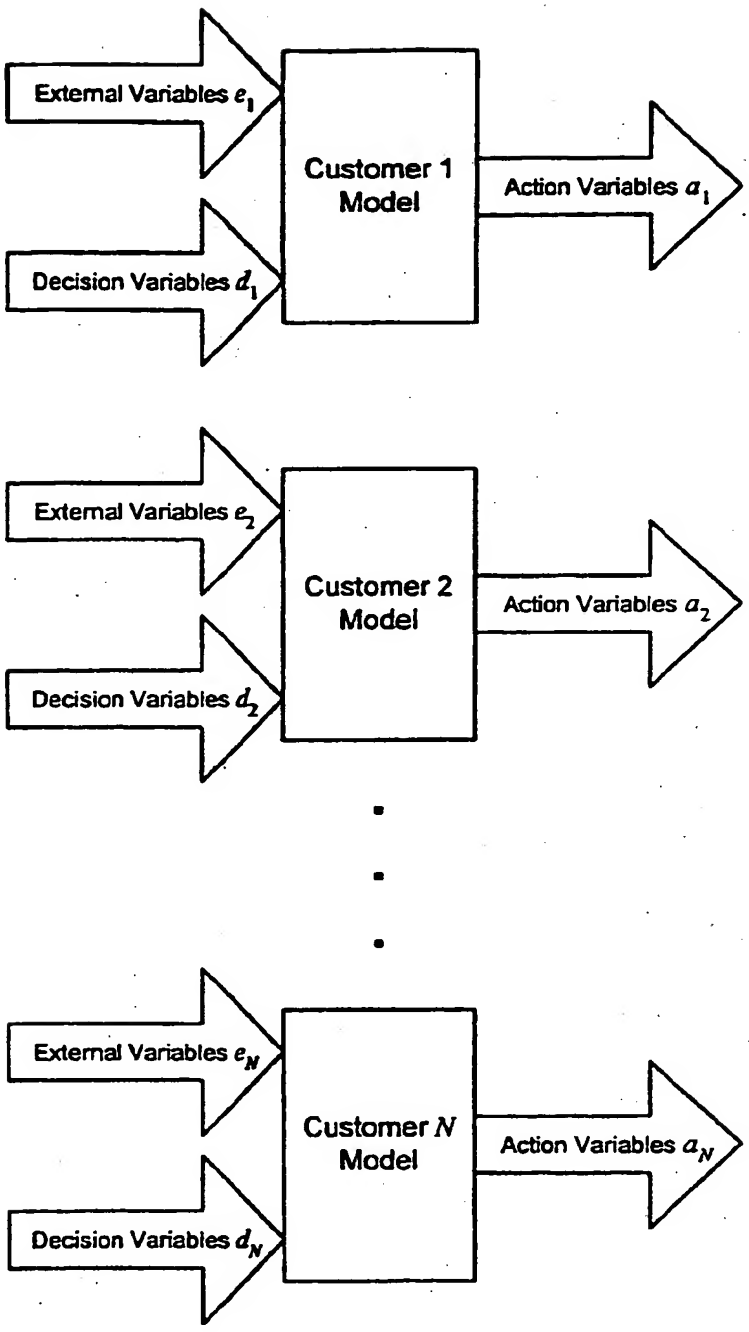
External Variables e_1
Decision Variables d_1
Customer 1 Model
Action Variables a_1
External Variables e_2
Decision Variables d_2
Customer 2 Model
Action Variables a_2
External Variables e_N
Decision Variables d_N
Customer N Model
Action Variables a_N

FIG. 7

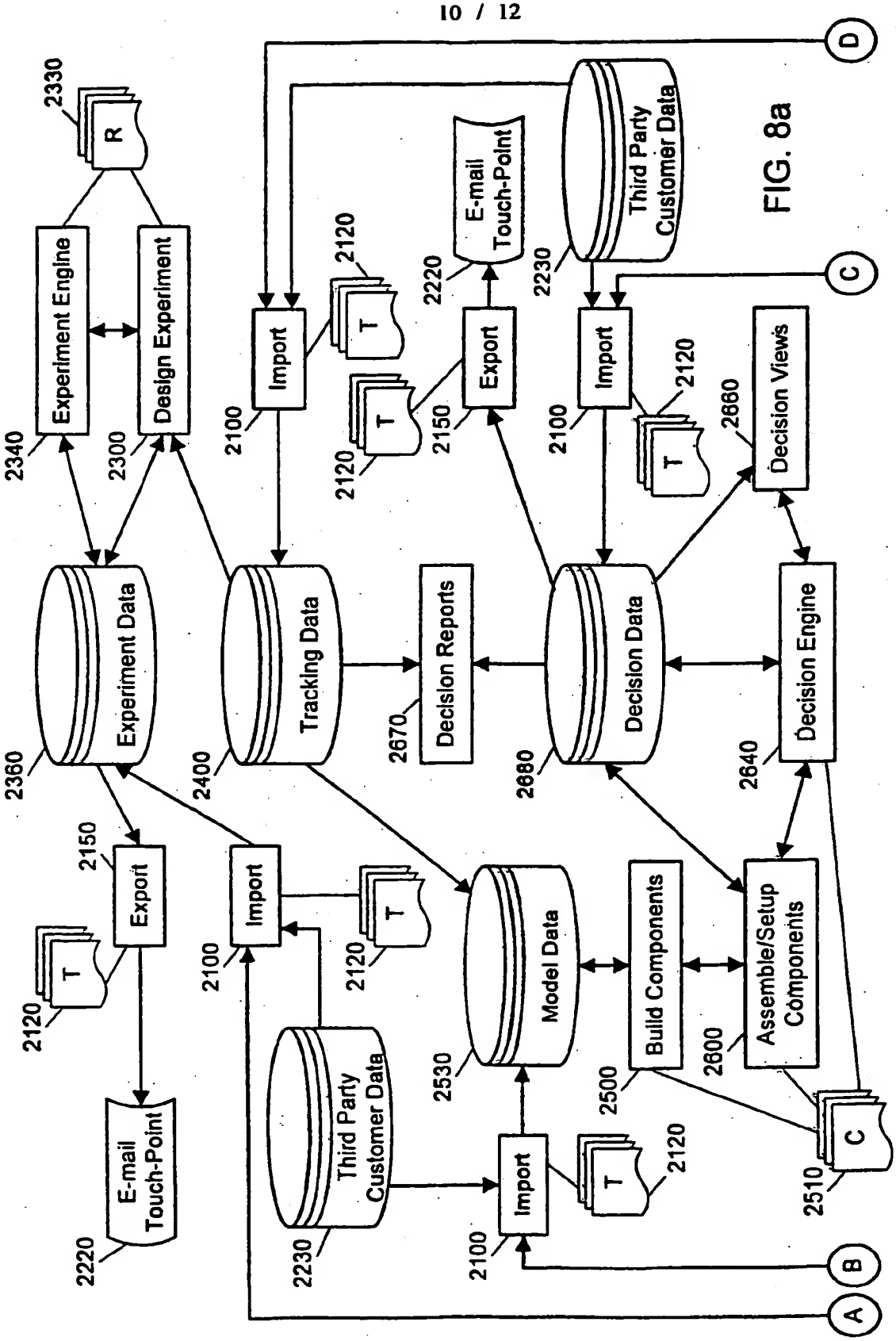
Experiment Engine
Design Experiment
Experiment Data
Tracking Data
Decision Reports
Decision Data
Decision Engine
Decision Views
Import
Export
E-mail Touch-Point
Third Party Customer Data
Model Data
Build Components
Assemble/Setup Components
R
T
C
2330
2340
2300
2360
2400
2670
2680
2640
2660
2100
2120
2150
2220
2230
2530
2500
2600
2510
A
B
C
D

FIG. 8a

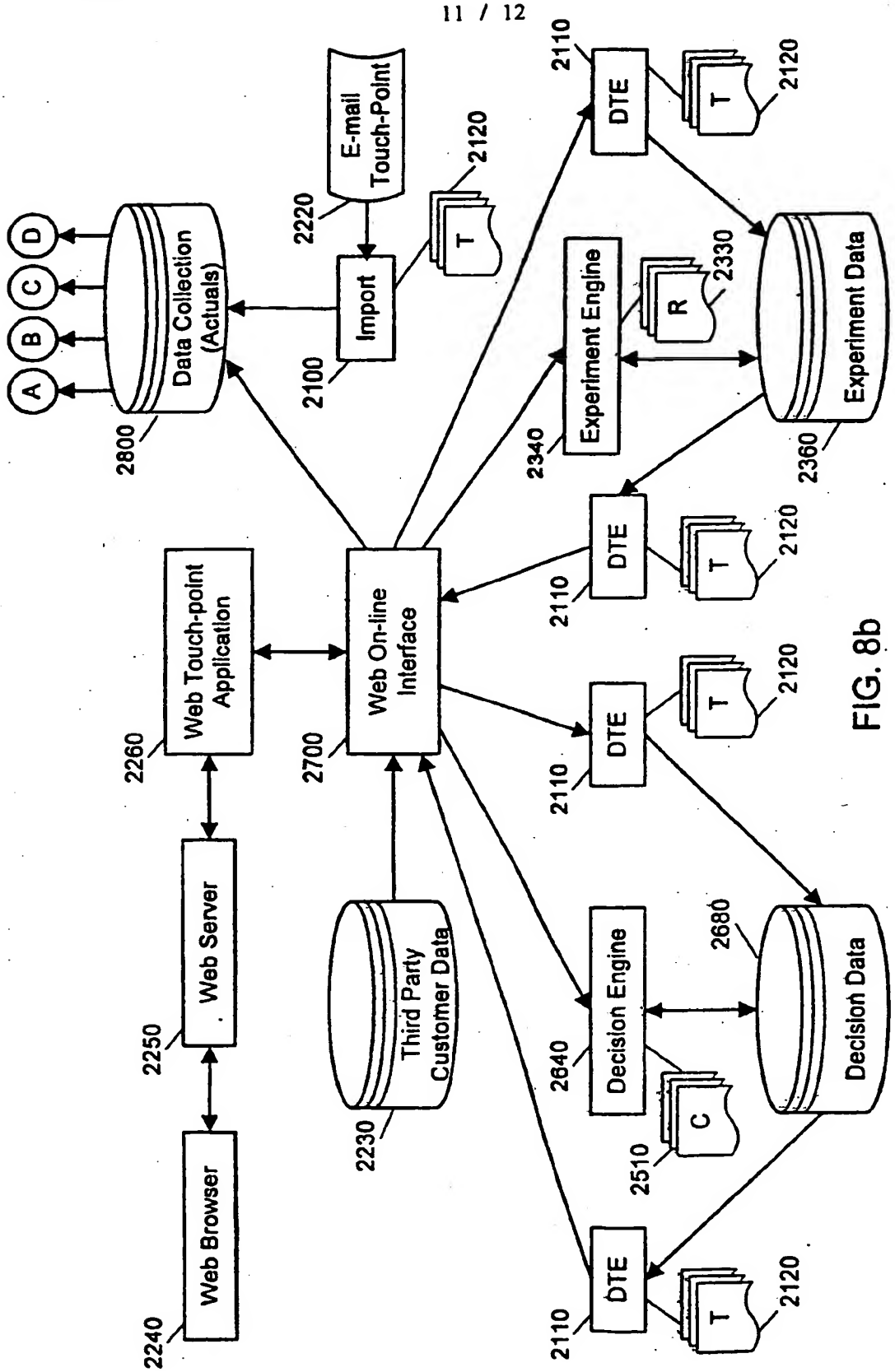
A
B
C
D
Data Collection (Actuals)
2800
E-mail Touch-Point
2220
Import
2100
T
2120
2110
DTE
Experiment Engine
2340
R
2330
Experiment Data
2360
Web Touch-point Application
2260
Web On-line Interface
2700
Web Server
2250
Web Browser
2240
Third Party Customer Data
2230
Decision Engine
2640
C
2510
Decision Data
2680

FIG. 8b

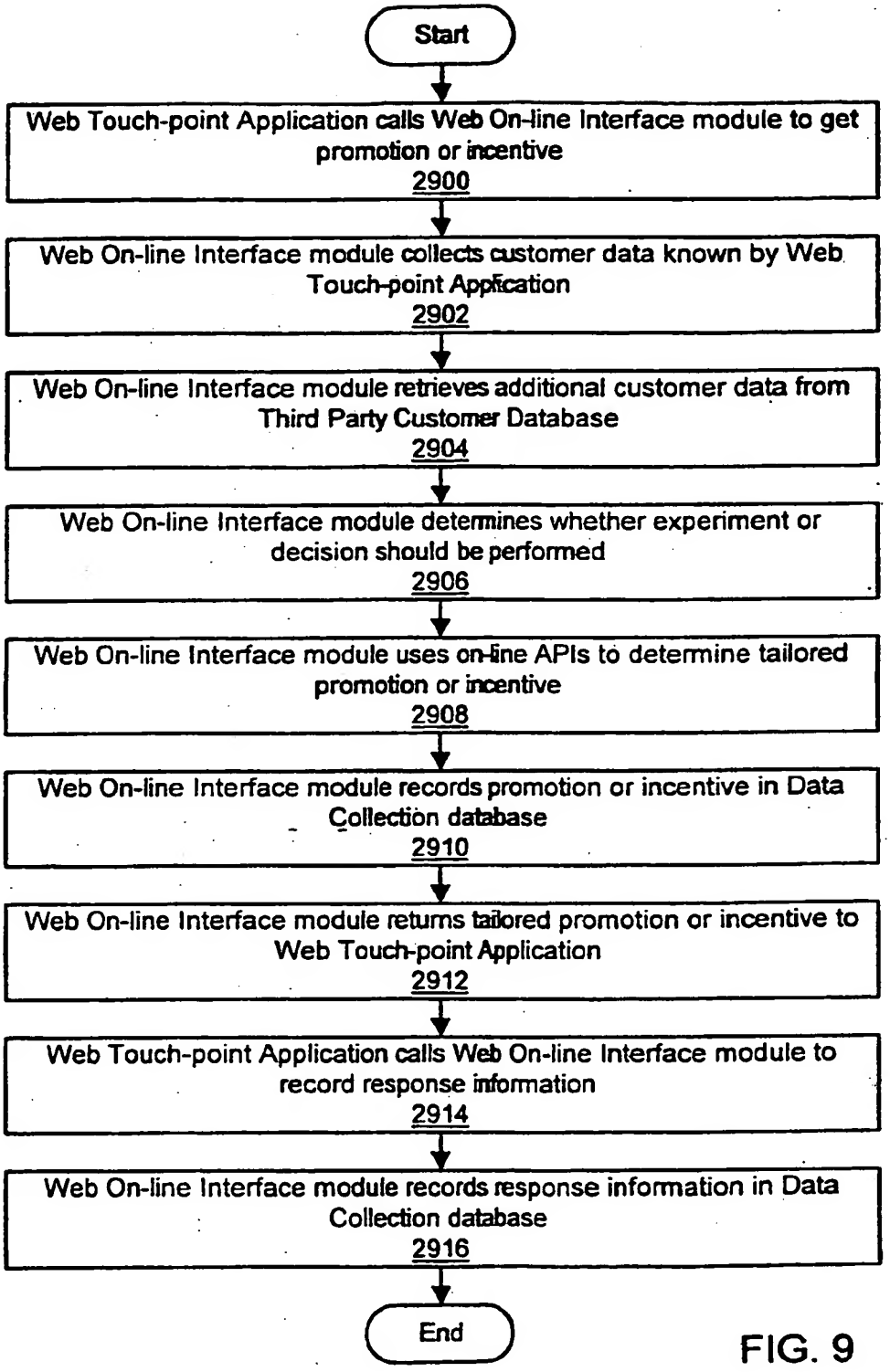
Start
Web Touch-point Application calls Web On-line Interface module to get promotion or incentive
2900
Web On-line Interface module collects customer data known by Web Touch-point Application
2902
Web On-line Interface module retrieves additional customer data from Third Party Customer Database
2904
Web On-line Interface module determines whether experiment or decision should be performed
2906
Web On-line Interface module uses on-line APIs to determine tailored promotion or incentive
2908
Web On-line Interface module records promotion or incentive in Data Collection database
2910
Web On-line Interface module returns tailored promotion or incentive to Web Touch-point Application
2912
Web Touch-point Application calls Web On-line Interface module to record response information
2914
Web On-line Interface module records response information in Data Collection database
2916
End

FIG. 9